INTEGRATED EXERCISE DETECTION DEVICE EMPLOYING SATELLITE POSITIONING SIGNAL AND EXERCISE SIGNAL

BACKGROUND OF THE INVENTION

[0001] Field of the Invention

[0002] The present invention relates generally to a device for detection conditions of outdoor exercises, and in particular to a device for detecting exercise conditions of bicycle riding by employing both satellite positioning signals received from satellites of a Global Positioning System (GPS) and exercise signals provided by sensors mounted on the bicycle/rider.

[0003] 2. The Related Art

[0004] Exercises have been an important daily activity for modern urbanites. Exercise devices for both indoor and outdoor exercises are commonly available in the market. To ensure the result of exercise, some exercise devices are equipped with an exercise detection device that detects the exercise conditions and shows the detection result to the users. For example, a senor can be mounted on the pedal crank of a bicycle to detect and record the revolution and rotation speed of bicycle wheels. Independent detection devices are also available for detection of exercise conditions, such as a step counter that is attached to the body of a user to count the number of steps/strides that the user takes.

[0005] Most of the exercise detection devices are of single function designs. In other words, they detect only one particular kind of signal, such as signal of physical condition of a user or signal of motion of an exercising device, for example speed of a moving bicycle. Devices that receive two kinds of signal for detection of exercise conditions, to the best the inventor knows, are not available in the market.

[0006] Global positioning system (GPS) is well known for detecting the

position of an object with the aids of radio frequency transmission from satellites. Satellite positioning signals obtained from GPS allows a user to know the position of an object at any particular time points and, based on the data of positions, the speed and moving distance can also be obtained. The GPS also provides data of altitude of the object in a global sense. Due to the fact that transmission of GPS signals between the satellite and a user may be interfered with by large objects that shield between the satellite and the user, GPS signals cannot actually reflect the exercise condition timely. In addition, taking bicycle riding as an example, the GPS provides only the information of displacement, speed and altitude of the bicycle and the rider. However, there is no way that a user of the GPS system can know information regarding pedaling of the rider, such as the pedaling speed (the rotational speed of the crank).

[0007] Thus, the present invention is aimed to provide an exercise detection device that employs signals from different sources for providing more precise condition of exercise to a user.

SUMMARY OF THE INVENTION

[0008] An object of the present invention is to provide an integrated exercise detection device that receives both satellite positioning signals from GPS satellites and exercise signals obtained from a person taking exercise with/without an exercise device whereby actual exercise conditions can be obtained by calibrating the signals with each other.

[0010] Another object of the present invention is to provide an exercise detection device comprising a satellite signal receiving/processing device that provides dynamic positional data and a device, such as velocity sensor, for detecting exercise conditions of a user, such as velocity, whereby both position and velocity, as well as other exercise conditions, can be provided timely.

[0011] A further object of the present invention is to provide an exercise detection device that is combined with a satellite signal receiving/processing

device whereby geometrical data, such as position, altitude as well as displacement and velocity that can be inferred from the geometrical data, and exercising data, such as number of steps taken and speed, of an exerciser can be provided to a user simultaneously.

[0012] To achieve the above objects, in accordance with the present invention, there is provided an integrated exercise detection device comprising a satellite positioning module and an exercise detection module. The satellite positioning module receives satellite signals associated with a user, such as a person riding a bicycle. The satellite positioning module comprises a microprocessor that processes the received satellite signals to generate first data including current position, displacement, velocity and altitude of the user and a communication interface. The integrated exercise detection device further comprises an exercise detection module that detects exercise signals of the user and generates second data in response thereto. The second data are transmitted to the microprocessor via for example electrical cables and/or wireless transmission comprised of wireless transmitter coupled to the exercise detection module and wireless receiver coupled to the microprocessor. A display is electrically coupled to the second microprocessor to selectively display the first and second data.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] The present invention will be apparent to those skilled in the art by reading the following description of preferred embodiments thereof, with reference to the attached drawings, in which:

[0014] **Figure 1** is a perspective view of an integrated exercise detection device constructed in accordance with the present invention;

[0015] **Figure 2** is a block diagram of a circuit of the integrated exercise detection device of a first embodiment of the present invention adapted to be used in **Figure 1**;

[0016] **Figure 3** is a block diagram of a circuit of the integrated exercise detection device of a second embodiment of the present invention adapted to be used in **Figure 1**;

[0017] **Figure 4** is a plot of stride length vs. stride rate;

[0018] **Figure 5** is a schematic view showing a person wearing the integrated exercise detection device of the present invention;

[0019] **Figure 6** is a block diagram of a circuit of the integrated exercise detection device of a third embodiment of the present invention adapted to be used in **Figure 5**;

[0020] **Figure 7** is a block diagram of a circuit of the integrated exercise detection device of a fourth embodiment of the present invention adapted to be used in **Figure 5**; and

[0021] **Figure 8** shows an application of the integrated exercise detection device on outdoor bicycle riding.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0022] With reference to the drawings and in particular to **Figure 1**, an integrated exercise detection device constructed in accordance with the present invention, generally designated with reference numeral **100**, is made in the form that can be worn on the body of a user, comprising a display device **102** connected to and retained by strips **101** on opposite sides thereof. The display device **102** may display information or data regarding time, step counts, velocity or speed, current position, displacement and altitude.

[0023] Also referring to **Figure 2**, a circuit of the integrated exercise detection device of a first embodiment of the present invention adapted to be used in **Figure 1** comprises a satellite positioning module **2** and an exercise detection module **3**,

both of which are electrically connected to a display unit **5** that constitutes in part of the display device **102**.

[0024] The satellite positioning module **2** comprises an antenna **20**, an RF (radio frequency) receiving circuit **21** that is connected to the antenna **20** for receiving satellite positioning signal through the antenna **20**, a multiple channels logic circuit **22** connected to the RF receiving circuit **21**, a first microprocessor **23** connected to the RF receiving circuit **21** via the multiple channels logic circuit **22**, an oscillator **24** providing oscillation signal to the first microprocessor **23** through a frequency divider **25**, a real time control (RTC) **26** connected to the first microprocessor **23** and memory means, including read only memory (ROM) **27** and random access memory (RAM) **28**, connected to the first microprocessor **23**. The first microprocessor **23** is electrically connected, via a communication interface **29** and communication lines Tx and Rx, to a second microprocessor **4**.

[0025] Satellite positioning signals are received by the RF receiving circuit **21** through the antenna **20** and then applied to the first microprocessor **23** through the multiple channels logic circuit **22**. The satellite positioning signals are processed by the first microprocessor **23**, which performs calculation based on pre-loaded algorithm to determine the current position, displacement, velocity and altitude of an exerciser. The data of current position, displacement, velocity and altitude are then transmitted by the communication interface **29** through the communication lines **Tx** and **Rx** to the second microprocessor **4** that controls the display unit **5** to display the data on the display device **102**. A user or the exerciser can inspect the exercise conditions by observing the display device **102**.

[0026] The exercise detection module **3** comprising a vibration/acceleration sensor **31** for detecting exercise signals, which may include for example a step counter or a velocity detector, issuing an exercise signal obtained from the exerciser. The exercise signal is amplified by an amplifier **32** and filtered by a filter **33**. The amplified and filtered signal is then waveform-shaped by a shaping circuit **34** before the signal is transmitted, via an electrical wire **34a**, to the second microprocessor **4** for display by the display unit **5**.

[0027] Referring to **Figure 3**, a circuit of the integrated exercise detection device of a second embodiment of the present invention adapted to be used in **Figure 1** comprises a microprocessor **6** to replace with the first microprocessor **23** and the second microprocessor **4** in **Figure 2**.

[0028] Similarly, satellite positioning signals are received by the RF receiving circuit **21** through the antenna **20** and then applied to the microprocessor **6** through the multiple channels logic circuit **22**. The satellite positioning signals are processed by the microprocessor **6**, which performs calculation based on pre-loaded algorithm to determine the current position, displacement, velocity and altitude of an exerciser. The microprocessor **6** is capable of controlling the display unit **5** to display the data on the display device **102**. A user or the exerciser can inspect the exercise conditions by observing the display device **102**.

[0029] The exercise detection module **3** comprising a vibration/acceleration sensor **31** for detecting exercise signals, which may include for example a step counter or a velocity detector, issuing an exercise signal obtained from the exerciser. The exercise signal is amplified by an amplifier **32** and filtered by a filter **33**. The amplified and filtered signal is then waveform-shaped by a shaping circuit **34** before the signal is transmitted, via an electrical wire **34a**, to the microprocessor **6** for display by the display unit **5**.

[0030] The exercise detection module **3** detects the exercise signals that are generated by the movement and action of the exerciser during taking an exercise, such as bicycle riding and calculating data regarding speed and distance on the basis of the detected exercise signals.

[0031] **Figure 4** is a plot of stride length vs. stride rate, which shows the relationship between the stride length and stride rate. The X-axis represents the stride rate of the user, and the Y-axis represents the stride length of the user. It is noted that a slower stride rate **R1** responses to a shorter stride length **L1**, while a faster stride rate **R2** responses to a longer stride length **L2**, as indicated in the plot. So, a regular curve L is obtained. According to the plot, the moving speed and

distance of the user during exercising may be calculated.

[0032] In other words, the stride length changes with the change of stride rate and such change may cause error in detection and/or determination of speed and distance by the exercise detection module **3**. In an aspect of the present invention, such an error can be corrected by comparison with data obtained from the satellite positioning signals that are provided by the satellite positioning receiver module **2**.

[0033] The exercise detection module **3** can be of any known device, such as a speed sensor that is conventionally known, including one-dimensional (X axis), two-dimensional (X and Y axes) or three-dimensional (X, Y and Z axes) acceleration sensor.

[0034] With reference to **Figure 5**, the integrated exercise detection device of the present invention can be worn on any suitable location on the body of the user. For example, the integrated exercise detection device includes a satellite positioning module **100a** which is made in the form of a wrist watch adapted to be worn on the wrist of the use, and an exercise detection module **100b** adapted to be simply worn on the waist of the user.

[0035] Referring to **Figure 6**, which shows a third embodiment of the integrated exercise detection device in accordance with the present invention, which is adapted to be used in **Figure 5**. This embodiment of the integrated exercise detection device is substantially identical to the first embodiment with reference to **Figure 2**. Thus, the same components will carry the same reference numeral references and no further detail will be given herein. Instead of connection of the exercise detection module **3** to the second microprocessor **4** by an electrical cable as shown in **Figure 2**, the exercise detection module **3** of the third embodiment is coupled to the second microprocessor **4** in a wireless manner. For example, the waveform-shaped exercise signals are processed by a transmitter circuit **35** for transmission in electromagnetic wave through an antenna **36**. The second microprocessor **4** comprises a receiving circuit **41** that receives the

exercise signals in the form electromagnetic wave through an antenna **42**. The received signals are the applied to the second microprocessor **4** for display by the display unit **5**.

[0036] Referring to **Figure 7**, a circuit of the integrated exercise detection device of a fourth embodiment of the present invention adapted used in **Figure 5** comprises a microprocessor **6** to replace with the first microprocessor **23** and the second microprocessor **4** in **Figure 6**.

[0037] Similarly, satellite positioning signals are received by the RF receiving circuit **21** through the antenna **20** and then applied to the microprocessor **6** through the multiple channels logic circuit **22**. The satellite positioning signals are processed by the microprocessor **6**, which performs calculation based on pre-loaded algorithm to determine the current position, displacement, velocity and altitude of an exerciser. The microprocessor **6** is capable of controlling the display unit **5** to display the data on the display device **102**. A user or the exerciser can inspect the exercise conditions by observing the display device **102**.

[0038] The exercise detection module **3** comprising a vibration/acceleration sensor **31** for detecting exercise signals, which may include for example a step counter or a velocity detector, issuing an exercise signal obtained from the exerciser. The exercise signal is amplified by an amplifier **32** and filtered by a filter **33**. The amplified and filtered signal is then waveform-shaped by a shaping circuit **34**. The waveform-shaped exercise signals are processed by a transmitter circuit **35** for transmission in electromagnetic wave through an antenna **36**. The microprocessor **6** comprises a receiving circuit **41** that receives the exercise signals in the form electromagnetic wave through an antenna **42**. The received signals are the applied to the microprocessor **6** for display by the display unit **5**.

[0039] The wireless connection between the exercise detection module **3** and the satellite positioning receiver module **2** allows the exercise detection module **3** to be mounted at a position remote from the satellite positioning receiver module

2. An example is shown in **Figure 8**, wherein the satellite positioning receiver module **100c** comprises a satellite positioning receiver module mounted to for example the handbar of a bicycle **7**, while the exercise detection module comprises a velocity sensor **100d** mounted to the pedal **71** of the bicycle **7** for detection of the revolution of the pedal **71**.

[0040] Pedaling signal detected by the exercise detection module is applied to the second microprocessor in for example the wireless manner as shown in **Figure 6**. The second microprocessor **4** perform calculation to obtain the revolution of the bicycle, which can then be converted into the speed of the bicycle. The speed of the bicycle may also be obtained from the satellite positioning signals and both speeds can be used to provide exact speed of the bicycle. For example, when the satellite signals are blocked by for example a tunnel, the speed obtained from the velocity sensor may be used alone to indicate the moving speed of the bicycle.

[0041] Although the present invention has been described with reference to the preferred embodiments thereof, it is apparent to those skilled in the art that a variety of modifications and changes may be made without departing from the scope of the present invention which is intended to be defined by the appended claims.